thickness and the "E" core and coil are located below the distal segments of the extensions **256**, e.g., mounted directly to the touchpad PCB itself. The coil wires can be soldered directly to the touchpad PCB.

[0122] **FIG. 10** is a top plan view of another translating surface embodiment **270** in which a separate moving tactile surface is positioned above, and in sliding contact with, the touchpad. This surface is translated relative to the touchpad by a high bandwidth actuator through a high fidelity mechanical linkage.

[0123] In this embodiment, a translating surface **272** is positioned over a touchpad **274**, similar to the embodiment of **FIG. 9**. An extension member **276** can protrude in a direction (x-direction here) towards a rotary actuator **278**, which is this example is grounded to the laptop housing **280**. The actuator **278** can be a DC rotary motor having a rotatable shaft **282** that is coupled to a coupling linkage **284** that is in turn coupled to the extension member **276**. For example, a portion of the linkage from the actuator assembly **150** described above can be used. When the actuator **278** rotates the shaft **282** in either direction, the linkage converts the rotation to surface **272** translation in a corresponding direction (left or right). For example, a displacement of about +/−1 mm can be achieved. The user feels the surface translation when moving a finger over the surface **272**. Motor rotation can result in very clean high fidelity translation in the X axis. A DC motor design may work in a laptop given spare volume out at the sides or locations in the front of the enclosure or housing. A similar extension, linkage and motor can be provided in the y-direction to move the surface **272** in that direction. The input of the user is detected on the touchpad through the moving tactile surface.

[0124] The thin surface can be trimmed to fit inside the touchpad area with a small border all around. A rectangular extension can be cut out of a larger lamination to provide a fairly rigid strip that is driven with an actuator. This strip should be wide enough to allow the actuator to push on it in operation without the strip buckling.

[0125] As in the embodiment of **FIG. 9, a** smooth surface can be provided on the underside of surface 272 that contacts the touchpad to provide a smooth low-friction sliding interface with the touchpad plastic covering that the user's finger normally touches. The top side of the moving surface **272** can be made frictional to allow a good user grip, e.g. a texture like fine sandpaper. This can provide an excellent contact surface because it provides some mechanical bonding with the finger surface, but is not rough enough to feel rough to touch. Other embodiments can use a variety of types of friction surfaces. Other embodiments may also use flatter actuators, such as moving magnet actuators or voice coil actuators.

[0126] Two strips **286** of plastic or other material can be attached to the bezel surrounding the touchpad (i.e. the rim of the housing opening for the touchpad) and covering the edges of the surface **272** in order to constrain the moving surface **272** and keep it flat against and parallel to the touchpad **274**.

[0127] The embodiments of **FIGS. 9 and 10** can provide compelling haptic sensations. Adding a surface above the touchpad does not substantially interfere with the sensor operation of the touchpad. A user can concurrently point and receive haptic feedback through motion of this surface relative to the fixed touchpad. The perceived correlation of the imparted feedback with movement is good. It is simple for the user to point and navigate a cursor or other object (i.e., provide input to the laptop or other electronic device) when touching and moving a finger over the translation surface above the touchpad. In some embodiments, the moving surface can be held above, not in close contact with, the touchpad and so some compression by the user may be required to take the free play out and come into proximity with the sensor array.

[0128] When moving a cursor over displayed scroll bars and around on the desktop GUI displayed by the laptop, the user feels distinct, high fidelity effects that are well correlated spatially with the cursor. The character of the correlation may be different depending on whether the user moves a finger or object in the x- or the y-axis. The actuator in the shown embodiment **270** moves the surface **272** in the x-axis. Consequently, moving the cursor up and down over icons, the user may feel pops or similar tactile effects as unidirectional if the user does not concentrate on or observe that the motion of the surface **272** is perpendicular to the cursor motion.

[0129] Motion of the user's finger in the translated direction—the x-axis in the example of **FIG. 10**—tends to be more compelling. For example, as the user drags a finger in the x-direction to move a cursor from one displayed radio button to the next, the surface **272** may lead the user into the next button and can feel like a detent even though very small motions of the surface are being generated. A surface translation force opposing the direction of motion can be effective, e.g. if the user is moving left onto an icon, a translation force directed to the right feels crisp and natural. If haptic feedback is allowed in only one axis, the y-axis may be a better choice in some embodiments because there may be more vertically-oriented content on a GUI desktop and in applications.

[0130] A short, distinct pulse can provide excellent transitions when moving the cursor from one object to another, such as between graphical buttons. Vibrations can be conveyed to the user in surface translation embodiments by oscillating the actuator driving the surface, e.g. with a sine or other periodic wave, and thereby oscillating the translating surface in opposite directions.

[0131] The user also may naturally tend to take his or her finger off of the touchpad between motions that control the cursor, and an inherent spring centering of the motor and linkage can return the moving surface **252** or **272** to a neutral (origin) position, ready for the next interaction. The controlled cursor is not moved while the feedback apparatus has moved back to the neutral origin position, since only the surface above the touchpad moves and does not provide input to the computer through the touchpad like a user's finger. This subtlety is more readily provided in this embodiment than if the touchpad surface itself were translated, as in other embodiments described herein.

[0132] Motion in a particular direction allows the surface translation embodiments to act in some embodiments as a relative pointing device with local pseudo-kinesthetic feedback. Tactile feedback is still the primary type of haptic feedback provided in such an embodiment, but the small displacements of the surface can be dramatically perceived